

Linear rolling bearing**Field of the invention**

The present invention concerns a linear rolling bearing as used, for example in linear guides of machine tools. More particularly, the present invention concerns linear rolling bearings in which forces acting crosswise to the direction of guidance as well as torques are transmitted through the linear rolling bearing.

DE 41 38 026 A1, for instance discloses a linear rolling bearing comprising a guide carriage that can be mounted through rolling bearing rollers on a guide rail. The guide carriage comprises at least one endless roller channel for the rollers. The roller channel comprises a load-bearing channel for load-bearing rollers, a return channel for returning rollers and two deflecting channels that connect the load-bearing channel and the return channel to each other. The guide carriage comprises a carrier body in which the return channel and the load-bearing channel are arranged, and, on two front ends of the carrier body, end members in which the deflecting channels are arranged. The return channel comprises a return tube whose tube ends are connected to the end members. The roller channel comprises raceways for the rollers and side surfaces for laterally delimiting the roller channel. The return tube has a cylindric configuration with a long, stretched shape and a profiled end surface at each end. The ends or openings of the deflecting channels into the end members have a complementary profiled structure so that a matching or meshing connection is obtained between each profiled end surface of the return tube and the respective complementary profiled opening of the bent deflecting channel. The return tube that is made up of a plurality of longitudinal parts does not have a flat end surface but comprises a profiled fitting configuration. One of the halves of the return tube comprises on its ends projections that project in the longitudinal direction and comprise a recessed portion that is delimited by a horizontal side wall of the projection and a vertical

end surface. When assembled together, the projections of the complementary halves of the return tube have a crescent-shaped or segment-shaped structure. The recessed portion of the return tube registers with a corresponding projection of the end member, so that a positioning of the return tube and the end member relative to each other is assured. The projections and the recessed portions are shaped so as to prevent a free rotation of the return tubes in the through-bores.

A parting joint formed at the junction of the deflecting channel and the return channel is arranged substantially crosswise to the longitudinally extending return tube. In the case of large-size structures of such linear rolling bearings, a clearly enlarged parting joint may be formed due to an unfavorable tolerance situation. During their circulation through the roller channel, the rollers can then abut against edges of the return tube and/or of the end member that are formed at the parting joint. Disturbing rolling noises and possibly also damage can be caused that can even lead to a failure of the linear rolling bearing.

Objects of the invention

It is an object of the invention to provide a linear rolling bearing of the pre-cited type in which the aforesaid drawback is eliminated.

This and other objects and advantages of the invention will become obvious from the following detailed description.

Summary of the invention

The invention achieves the above objects by the fact that the return tube comprises tongues that engage into the end member and, through opposing tongue surfaces, form side surfaces of the deflecting channel, a parting joint between each tongue and the end member being arranged at least substantially parallel to the return tube. In the rolling bearing of the invention, unfavorable tolerance situations relating to the length of the return tubes and the tongues are

immaterial and have no influence on the size of the parting joint. Particularly in large-size structures with very long return tubes, larger tolerance variations can occur that in the case of prior art linear rolling bearings, lead to an enlargement of the transversely extending parting joint. In contrast, the parting joint, arranged according to the invention parallel to the return tube, is independent of tolerance variations in longitudinal direction.

The end member may comprise a concave outer raceway for the rollers. The tongues then cross a plane in which the concave outer raceway is situated. Attention must be paid in this respect only to the fact that the tongues are at least that long that the free ends of the tongues cross the plane in which the concave outer raceway is situated. This then assures that the free end of the tongue is in no case arranged within the roller channel. Tolerance variations in longitudinal direction thus have no influence on the configuration of the deflecting channel and the parting joint. Further, the fact that the parting plane extends parallel to the return tube permits an unproblematic insertion of the return tubes into the end members. The end member preferably comprises receptions for the tongues, said receptions being arranged such that the return tube is perfectly aligned when it is inserted into the end member. This perfect alignment is required for assuring the correct angular position of the return tube relative to the return channel because, otherwise, the rollers could tilt when leaving the deflecting channel and entering the return channel.

According to a further feature of the invention, the end member comprises side parts whose opposing end-member surfaces form, together with the opposing tongue surfaces, the side surfaces of the deflecting channel, the concave outer raceway of the deflecting channel being arranged between the side parts. It is particularly advantageous in this connection to provide a positioning device through which the opposing tongue surfaces of the tongues are retained in a common plane with the opposing end-member surfaces. In this way, a smooth side surface is formed in the deflecting channel, so that a tilting of the rollers is excluded. According to this proposition of the invention, the parting joint is defined

by the tongue and the side part, the part joint being arranged, here, too, parallel to the return tube.

The end member may comprises a head piece retained on the carrier body and a deflecting shell arranged in the head piece, said deflecting shell comprising said concave outer raceway for the rollers.

Preferably, the deflecting shell may also comprise the side parts, said side parts comprising openings forming the receptions for the tongues. When the tongues have been inserted into the receptions of the side parts, these side parts and the return tubes are perfectly aligned to each other, so that the deflecting channel and the return channel correspond perfectly to each other and a perfect circulation of the rollers is guaranteed.

The invention will now be described more closely with reference to one example of embodiment illustrated in a total of sixteen figures.

Brief description of the drawings

- Fig. 1 is a cross-section through a linear rolling bearing of the invention,
- Fig. 2 is a detail showing a return tube of the linear rolling bearing of the invention, in perspective,
- Fig. 3 shows one half of the return tube of Fig. 2,
- Fig. 4 shows a partial longitudinal section through the linear rolling bearing of Fig. 1,
- Fig. 5 is a perspective representation of a part of the return tube and a part of the end member of the linear rolling bearing of Fig. 1,

- Fig. 6 is a simplified representation of the return tube connected to the end member,
- Fig. 7 is a partial perspective representation of the end member and the return tube,
- Fig. 8 is a further perspective representation of the end member,
- Fig. 9 is a simplified representation of the tongue of the return tube arranged in the end member,
- Fig. 10 shows a section along line X-X of Fig. 9,
- Fig. 11 is a perspective representation of the middle retaining bar as a separate part,
- Fig. 12 shows one half of the middle retaining bar in perspective,
- Fig. 13 is a simplified representation of a section through the middle retaining bar along line XIII-XIII of Fig. 11,
- Fig. 14 is a perspective representation of a modified middle retaining bar,
- Fig. 15 is a simplified representation of the tongue of the middle retaining bar of Fig. 14 arranged in the end member, and
- Fig. 16 is a schematic representation of a longitudinal section of the middle retaining bar arranged in the end member.

Fig 1 shows a cross-section of a linear guide of the invention comprising a guide carriage 1 that is mounted through rolling bearings on a guide rail 2. The guide carriage 1 comprises a carrier body 3 and end members 4 (see Fig. 4) that are

fixed on the two front ends of the carrier body 3. The carrier body 3 comprises two guide legs 5 and a connecting bar 6 that connects these guide legs 5 integrally to each other such that a U-shaped carrier body 3 is formed. The guide carriage 1 is mounted slidably through rollers 7 on the guide rail 2. The rollers 7 are arranged in roller channels 8. Each roller channel 8 comprises a load-bearing channel 9 for load-bearing rollers 7, a return channel 10 for returning rollers 7 and two deflecting channels 11 that connect the load-bearing channel 9 and the return channel 10 to each other. The roller channel 8 comprises raceways 12, 13, 14, 15, 16, 17 for the rollers 7. The raceways 12 are configured on the guide rail 2. Two of these raceways 12 are arranged at an angle of approximately 90° to each other on each long side of the guide rail 2. Corresponding raceways 13 are configured on the two guide legs 5 of the carrier body 3. With such an arrangement of the rollers 7, the guide carriage 1 can transmit forces acting crosswise to the guide rail 2 as well as torques. A concave outer raceway 15 and a convex inner raceway 14 for the rollers 7 are configured in the deflecting channel 11. Raceways 16 and 17 for the rollers 7 are configured on opposing sides of the return channel 10. The roller channel 8 further comprises side surfaces 18, 19, 20, 21, 22, 23, 54 for laterally delimiting the roller channel 8. The side surfaces 18 are configured on opposing sides of the return channel 10. The side surfaces 22, 23, 54 are configured in the deflecting channel 11, and the side surfaces 19, 20, 21 are configured in the load-bearing channel 9.

Retaining bars 24, 25, 26 are arranged on the two front ends of the rollers 7 in the load-bearing channel 9 and are distinguished in the following as an upper retaining bar 24, a middle retaining bar 25 and a lower retaining bar 26. The side surface 19 is configured on the upper retaining bar 24, the side surface 20 is configured on the middle retaining bar 25 on a side facing the upper retaining bar 24. The side surface 21 is configured on the lower retaining bar 26 and a further side surface is configured on the middle retaining bar 25 on a side facing the lower retaining bar 26. The retaining bars 24, 25, 26 surround the rollers 7 such that the rollers 7 are retained secure against loss on the guide carriage 1. This is particularly advantageous when the guide carriage 1 is removed from the guide rail 2.

The invention further provides a return tube 27 with a substantially smooth outer cylinder surface, a contour being configured within the return tube 27 for forming the return channel 10. The carrier body 3 comprises a total of four through-bores 28 in each of which one return tube 27 is inserted.

The end member 4 (Fig. 4) comprises a head piece 29 that is fixed on the carrier body 3. In the head piece 29 is arranged a deflecting shell 30 whose side parts 31 comprise end-member surfaces 32 on opposing sides, said end-member surfaces 32 constituting the aforesaid side surfaces 22 of the deflecting channel 11. Between the two side parts 31 of a deflecting shell 30 is configured, on the deflecting shell 30, the outer concave raceway 15.

Figs. 2 and 3 show the return tube 27 that is composed of two identical longitudinal parts 28. Two tongues 33 are integrally formed on each end of the return tube 27. Opposing tongue surfaces 34 form the aforesaid side surfaces 23 of the deflecting channel 11. This can be clearly seen in Fig. 4. These tongues 33 engage into the end member 4. Fig. 5 shows the return tube 27 and the head piece 29, the return tube 27 being oriented relative to the head piece 29 such that the tongues 33 can be introduced into the head piece 29.

Fig. 7 shows the head piece 29 and the return tube 27 with inserted tongues 33.

From Fig. 8 it can be seen that the deflecting shell 30 comprises openings 35 that form receptions 36 for the tongues 33 of the return tube 27.

Fig. 6 is a schematic representation of the return tube 27 inserted into the end member 4. Roughly indicated in this figure is the deflecting channel 30 with the concave outer raceway 15, and one of the tongues 33 of the return tube 27 is shown in broken lines. The tongues 33 cross a plane in which the concave outer raceway 15 is arranged. This means that the free ends of the tongues 33 are situated beyond this raceway 15. Fig. 6 further shows that a parting joint 37 is

arranged parallel to the return tube 27 between each tongue 33 and the end member 4. In the present example of embodiment, the parting joint 37 is defined by the tongue 33 and the side part 31 of the deflecting shell 30.

The described connection between the return tube 27 and the end member 4 is particularly suitable for large-dimension components. A parting joint between a return tube and an end member in known linear rolling bearings is arranged crosswise to the longitudinal axis of the return tube, so that the parting joint is defined by the free end of the tongue. If due to an unfavorable tolerance situation in such prior art constructions, the length of the tube falls somewhat short of the required length, the parting joint can become so wide that undesired running noise and other disturbances in the circulation of the rolling bearings can be generated. In the linear rolling bearing of the invention, such tolerance variations have no influence on the parting joint because this extends in the longitudinal direction of the return tube 27. In any case, it is assured that the free end of the tongue 33 is situated beyond the deflecting channel 11.

A positioning device 38 is provided for assuring that the opposing tongue surfaces 34 are arranged in a common plane with the opposing end-member surfaces 32 of the end member 4, said opposing tongue surfaces 34 and said opposing end-member surfaces 32 forming the side surfaces 22 and 23 of the deflecting channel 11.

Fig. 9 shows a possible practical embodiment of a positioning device 38. In this arrangement, the positioning device comprises support sections 39 that are arranged on oppositely oriented tongue sides of the tongues 33, positioning sections 40 that are arranged on opposing tongue sides, stop sections 41 on the end member 4, said positioning sections 40 of the tongues 33 abutting against said stop sections 41 of the end member 4, and bearing sections 42 on the end member 4, said support sections 39 of the tongues 33 being supported on said bearing sections 42 of the end member 4.

In the present case, the support sections 39 are supported indirectly on the bearing section 42 of the end member 4 through a squeezable rib 43 which is integrally formed on the end member 4. The squeezable rib 43 is wedge-shaped so that the tongues 33 when being pushed in get increasingly wedged between the positioning sections 41 of the end member 4 and the squeezable ribs 43.

The distance between the positioning sections 40 of the tongue 33 and the tongue surface 34, and the distance between the stop sections 41 of the end member 4 and the end-member surface 32 of the end member 4 are matched to each other so that the end-member surface 32 and the tongue surface 34 lie in a common plane. This assures that the side surfaces 22 and 23 of the deflecting channel 11 lie in a common plane. The rollers 7 cannot hook or tilt but, much rather, they circulate smoothly in the deflecting channel 11. All that is needed when making the side surfaces 22 and 23 is to respect the aforesaid distances exactly. Tolerance variations at other points of the end member 4 or the return tube 27 have no influence on the position of the tongue surface 34 and the end-member surface 32 relative to each other.

Figs. 11 to 13 show the specially configured middle retaining bar 25. This bar is formed out of two identical longitudinal parts 44. The two-piece configuration is of particular advantage when retaining bars have to be provided for large structures. In such cases, the retaining bars can have a length of 200 mm and more, and a cross-section of 7 mm and more. Such retaining bars are made preferably out of plastic by injection molding. During the cooling process in the injection mold, in the case of one-piece retaining bars, an undesired irregular solidification of the plastic mass can occur that leads to an undesired deformation of the retaining bar. With the two-piece, or even three-piece or four-piece configuration of the retaining bar proposed by the invention, these drawbacks are eliminated because the cross-sections in the mold of the tool can be chosen so that an undesired deformation does not occur. In preferred manner, these two longitudinal parts 44 enclose a hollow space 45 along their entire length, so that the wall thicknesses along their length are substantially constant and are dimensioned in any case such that a

perfect cooling without undesired deformation is guaranteed. The hollow space is formed by recesses 46 that are arranged on the longitudinal parts 44 on their opposing parting sides 47. As best seen in Fig. 12, the longitudinal parts 44 comprise webs 48 and, for forming a plug connection 49, the webs 48 of the two longitudinal parts 44 engage into each other to form the retaining bar 25.

If the two longitudinal parts 44 comprise projections and recesses on their opposing parting sides 47, one projection and one recess is arranged on each longitudinal part symmetrically to a transverse center line of the retaining bar 25. With this symmetric arrangement, the two longitudinal parts 44 can be identically configured and inserted into each other without any problem.

Each longitudinal part 44 comprises a partial peg 50 on each of its two ends. When the two longitudinal parts 44 are connected to each other, the partial pegs 50 form a peg 51 at each end. The pegs 51 are inserted into corresponding peg receptions of the end member 4. This configuration of the pegs and the insertion of the pegs into receptions contributes to a perfect connection of the two longitudinal parts of the retaining bar.

Fig. 14 shows a perspective representation of the middle retaining bar 25. On its ends, the retaining bar 25 comprises tongues 52, and the tongue surface 53 of each tongue 52 forms a side surface 54 of the respective deflecting channel 11. Similar to the tongues 33 of the return tube 27, the tongues 52 cross the plane in which the concave outer raceway 15 of the end member 4 is arranged. This means that the free ends of the tongues 52 are arranged beyond this raceway 15. Here, too, a parting joint 55 between the tongue 52 and the end member 4 is arranged parallel to the retaining bar 25. In the present example of embodiment, the parting joint 55 is defined by the tongue 52 and the side part 31 of the deflecting shell 30. In this case, too, the advantage of the invention that tolerance variations in the length of the retaining bar 25 have no influence on the width of the parting joint 55 is obtained. Accordingly, the rollers 7 can pass smoothly with their front ends through the deflecting channel 11.

To assure that the tongue surfaces 53 are arranged in a common plane with the end-member surfaces 32, said tongue surfaces 53 and said end-member surfaces 32 forming the side surfaces 54 and 22 of the deflecting channel 11, the invention provides a further positioning device 56.

Fig. 15 shows the arrangement of the tongue 52 of the retaining bar 25 in the end member 4 with the positioning device 56, in a schematic representation. This positioning device 56 comprises a support section 57 that is arranged on the side of the tongue 52 opposite from the tongue surface 53, a positioning section 58 that is arranged on the side of the tongue 52 comprising the tongue surface 53, a stop section 59 on the end member 4, said positioning section 58 of the tongue 52 abutting against the stop section 59 of the end member 4, and a bearing section 60 on the end member 4, said support section 57 of the tongue 52 being supported on the bearing section 60 of the end member 4. In the present example, the support sections 57 are supported indirectly on the bearing section 60 of the end member 4 through squeezable ribs 61 that are formed, in the present example, integrally on the end member 4. The squeezable ribs 61 are wedge-shaped so that the tongues 52 when being pushed in get increasingly wedged between the positioning sections 58 of the end member 4 and the squeezable ribs 61.

The distance between the positioning sections 58 of the tongue 52 and the tongue surface 53, and the distance between the stop sections 59 of the end member 4 and end-member surface 32 of the end member 4 are matched to each other so that the end-member surface 32 and the tongue surface 53 lie in a common plane. This assures that the side surfaces 22, 23, 54 of the deflecting channel 11 lie in a common plane. The rollers 7 cannot hook or tilt but, much rather, they circulate smoothly in the deflecting channel 11. All that is needed when making the side surfaces 22, 23, 54 is to respect the aforesaid distances exactly. Tolerance variations at other points of the end member 4 or the retaining bar 25 have no

influence on the position of the tongue surface 53 and the end-member surface 32 relative to each other.